## Measurement of Fluid Thermal Conductivity with Anodized Tantalum Wires

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Hot wires are commonly used to measure the thermal conductivity of fluids using both transient and steady-state modes of operation. If the fluid is very polar, with significant electrical conduction, measurement errors become significant when bare wires are directly immersed in the fluid of interest. Anodized tantalum hot-wires have been shown to exhibit good electrical isolation from electrically conducting fluids during transient hot-wire measurements at moderate temperatures. This paper describes our experience using anodized tantalum hot wires for both transient and steady-state measurements of thermal conductivity at temperatures from 300 to 550 K.

The smallest commercially available tantalum wires are 25 µm in diameter. This is quite large for transient hot-wire measurements, particularly in the gas phase, since corrections for the finite wire diameter increase in proportion to the wire radius squared. It is shown that first order approximations for the finite wire radius are inadequate for gas phase measurements with 25 µm wires. Furthermore, since the uncertainty of the transient hot-wire results must increase in proportion to the magnitude of the corrections, gas phase measurements are also made with the same wires operated in a steady-state mode. When the transient corrections are carefully considered, good agreement is found between the steady-state and transient results in the gas phase.

Previous measurements with anodized tantalum hot wires have generally been limited to temperatures below 400 K so it is valuable to examine the stability of the resistance versus temperature characteristics at elevated temperatures. The resistance of several sets of anodized hot wires was continuously monitored at temperatures to 550 K during the experiments described here. It was found that wire resistance increased as a function of elapsed time at temperatures above 500 K. This demonstrates the necessity of in-situ wire calibration procedures when these wires are used at high temperatures.